

Innovations in Manufactured Housing and Modular Classrooms

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Outline

- Introduction to PNNL
- SIPs Manufactured Home
- Northwest Collaborative for Smart Portable Classrooms – Monitoring Efforts

PNNL Building Efficiency Programs

Intelligent
Buildings



Market
Transformation



Codes and
Standards

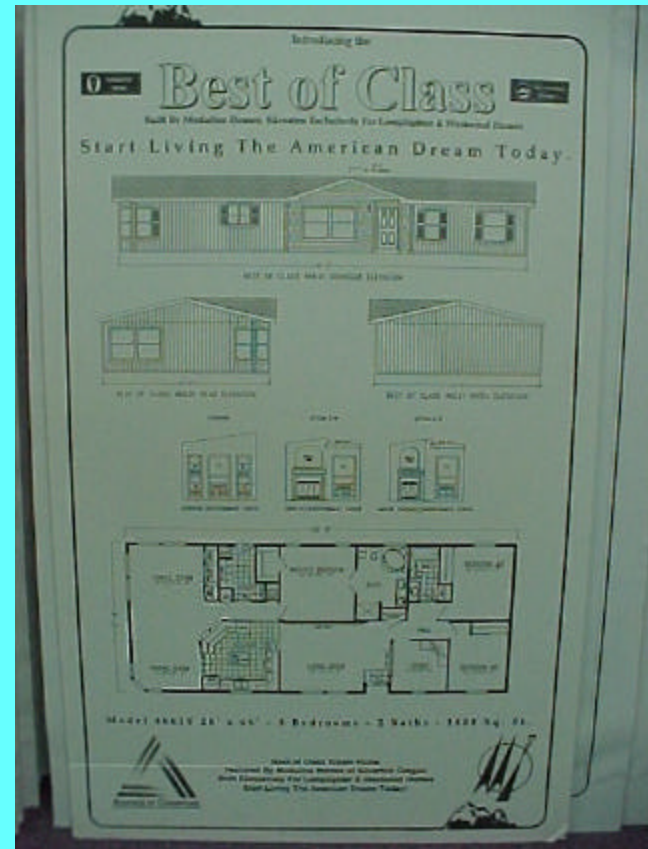


SIPs Manufactured Home

Objective: Design and construct a HUD-code manufactured home on an existing assembly line.

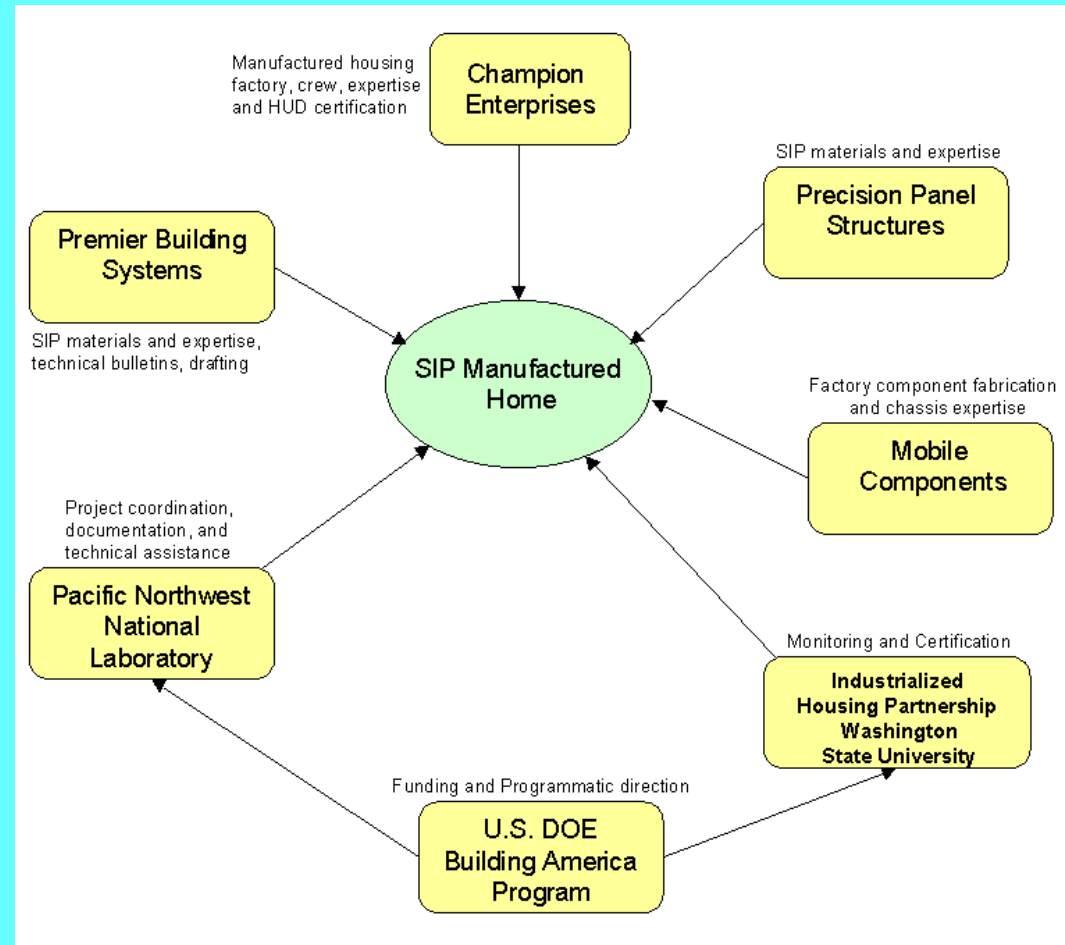
Key Steps:

- Recruit Partners: Champion Enterprises, Premier Building Systems, Precision Panels
- Modify existing design for SIPs: Simplicity, focus on building envelope, stable production processes, structural engineering



SIPs Manufactured Home - Steps

- Seek 3rd party HUD-Code approval: documentation of engineering and structural testing
- Choose and prepare the facility: materials flows and crew training
- Build the house: expert crews, document progress, press relations
- Short and long-term monitoring



SIPs Manufactured Home - Findings



- 3rd party approval is no trivial matter
- Verify all design assumptions between suppliers and the factory
- Optimize and standardize designs for SIP storage and efficiency

- The number of individual envelope components was drastically reduced from over a 1000 to under a 100

- Modify materials selection and handling



SIPs Manufactured Home - Findings

- The existing assembly line can accept SIPs for individual orders or as a dedicated product.
- SIPs streamline many stations, especially those dealing with insulation
- More work needed on ducts, plumbing, and electrical





Battelle

U.S. Department of Energy
Pacific Northwest National Laboratory

SIPs Manufactured Home – Performance

- Energy Modeling predicted 50% heating and cooling savings compared to standard HUD-code and 20% greater savings than SGC

- Super Good Cents and Energy Star Certified

- Monitoring will confirm performance

- Blower door testing confirmed SGC compliance with temporary set up

Component	Area (net)	Energy Efficiency	
		SIP	HUD-Code
Walls	1222	R-25 (U-0.040)	R-11 (U-0.089)
Windows	121	0.38 U-factor	0.55 U-factor
Door	22	U-0.20	U-0.35
Ceiling	1352	R-32 (U-0.0313)	R-30 (U-0.035)
Skylights	16	0.50 U-factor	0.55 U-factor
Floor	1368	R-32 (U-0.0313)	R-19 (U-0.047)
Infiltration	N/A	0.375 ACH	0.50 ACH
Duct efficiency	N/A	85%	80%

SIPs Manufactured Home – Performance

Design features include cathedral ceilings and sky lights



Excelled in a 300 mile road test without corner bracing

Modular Classrooms

- Goals
 - Energy Efficiency
 - Affordable Education
 - Market Transformation
- Collaborative Approach
 - State Energy Offices in Washington, Oregon, and Idaho
 - Manufacturers and Vendors
 - School Districts and State agencies
 - Building America and the IHP

Modular Workshop

- Held 26 March in Portland
- Relationship Building with districts, manufacturers, and agencies
- Attendance
 - 5 school districts from three states
 - Agencies from 5 states including the CEC and Florida
 - 3 manufacturers
 - 2 national labs – PNNL and ORNL

Monitoring – PNNL's Key Role

Current Sites

Marysville pair



Boise pre and post

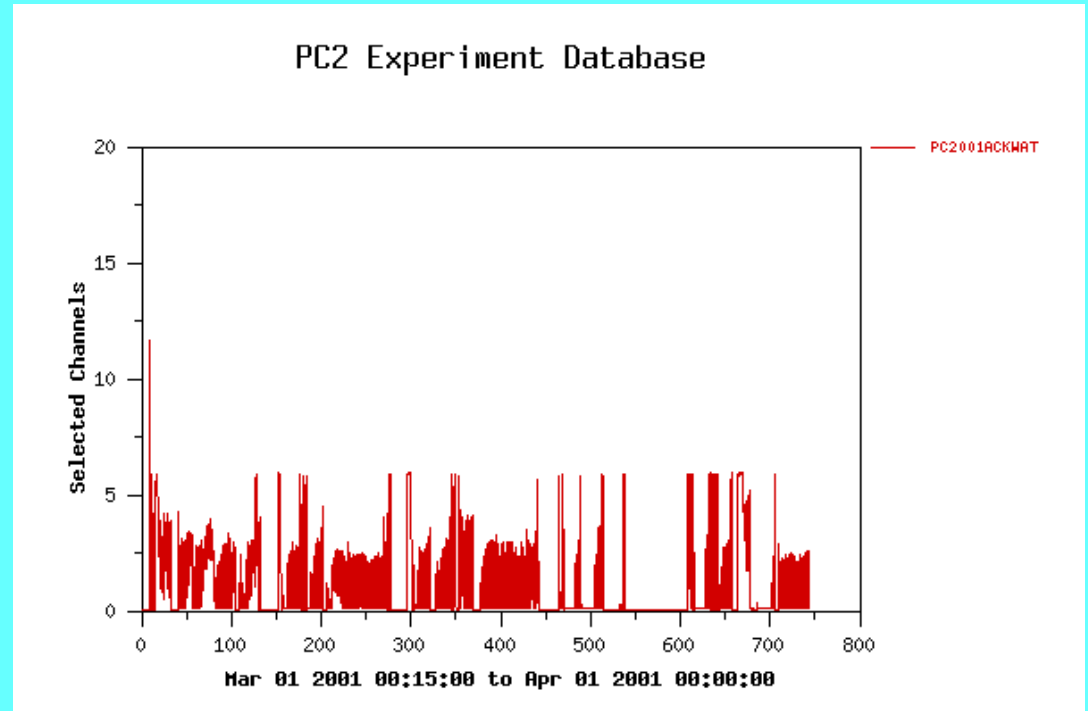
Anticipating a Portland area
matched pair this summer

Monitoring – Initial Findings

Monitoring has been used for real time diagnostics

- Value of setbacks
- Need for Commissioning
- Classroom education
- Energy management

Bulk of analysis will occur next year.



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